Climate change beliefs and savings behavior: a macroeconomic perspective

Hannah Römer

October 28, 2025

University of Oxford

Motivation: Anticipation of climate change impacts

Climate change is projected to incur large damages to the global economy.

Motivation: Anticipation of climate change impacts

Climate change is projected to incur large damages to the global economy.

- Possibly large impacts of anticipation
- Crucial role of beliefs

Motivation: Anticipation of climate change impacts

Climate change is projected to incur large damages to the global economy.

- Possibly large impacts of anticipation
- Crucial role of beliefs

Individual savings as self insurance

- Consumption smoothing, precautionary motives, decreasing returns...

Motivation: Anticipation of climate change impacts

Climate change is projected to incur large damages to the global economy.

- Possibly large impacts of anticipation
- Crucial role of beliefs

Individual savings as self insurance

- Consumption smoothing, precautionary motives, decreasing returns...

Research questions:

1. Do beliefs over climate change affect individual savings?

Motivation: Anticipation of climate change impacts

Climate change is projected to incur large damages to the global economy.

- Possibly large impacts of anticipation
- Crucial role of beliefs

Individual savings as self insurance

- Consumption smoothing, precautionary motives, decreasing returns...

Research questions:

1. Do beliefs over climate change affect individual savings?
2. What are the macroeconomic implications of climate concern via capital accumulation?

Motivation: Anticipation of climate change impacts

Climate change is projected to incur large damages to the global economy.

- Possibly large impacts of anticipation
- Crucial role of beliefs

Individual savings as self insurance

- Consumption smoothing, precautionary motives, decreasing returns...

Research questions:

1. Do beliefs over climate change affect individual savings?
2. What are the macroeconomic implications of climate concern via capital accumulation?
3. Does disagreement over climate impacts matter on aggregate? Distributionally?

This paper: micro to macro

Micro behavior

Macro effects

This paper: micro to macro

Micro behavior

- Analytic consumption-savings model in partial equilibrium
  - ➢ Savings $\uparrow$ if higher concern over productivity impacts
  - ➢ Drivers of response size: MPS, state-dependent marginal value of savings

Macro effects

This paper: micro to macro

Micro behavior

- Analytic consumption-savings model in partial equilibrium
  - ➢ Savings $\uparrow$ if higher concern over productivity impacts
  - ➢ Drivers of response size: MPS, state-dependent marginal value of savings
- Empirical evidence
  - ➢ Observational and causal UK survey evidence
  - ➢ Significant positive relationship between measure of climate change concern and savings choices

Macro effects

This paper: micro to macro

Micro behavior

- Analytic consumption-savings model in partial equilibrium
  - Savings $\uparrow$ if higher concern over productivity impacts
  - Drivers of response size: MPS, state-dependent marginal value of savings
- Empirical evidence
  - Observational and causal UK survey evidence
  - Significant positive relationship between measure of climate change concern and savings choices

Macro effects

- General equilibrium model with incomplete markets and aggregate risk
  - Non-stationary shift in stochastic productivity process
  - Uncertainty over trend in productivity

This paper: micro to macro

Micro behavior

- Analytic consumption-savings model in partial equilibrium
  - Savings $\uparrow$ if higher concern over productivity impacts
  - Drivers of response size: MPS, state-dependent marginal value of savings
- Empirical evidence
  - Observational and causal UK survey evidence
  - Significant positive relationship between measure of climate change concern and savings choices

Macro effects

- General equilibrium model with incomplete markets and aggregate risk
  - Non-stationary shift in stochastic productivity process
  - Uncertainty over trend in productivity
- Aggregate and distributional outcomes along the transition
  - Climate concern effect increases capital, attenuates output loss from climate change
  - Labor income $\uparrow$, wealth inequality $\downarrow$
  - Small but persistent negative impacts of disagreement

Contributions

Climate change impacts on the macroeconomy

- Stochastic damages: Golosov et al. (2014), Cai and Lontzek (2019)
- Anticipation: Bilal and Rossi-Hansberg (2023), Bakkensen and Barrage (2022)

Contribution: Amplified consequences of uncertainty in decentralized framework

Contributions

Climate change impacts on the macroeconomy

- Stochastic damages: Golosov et al. (2014), Cai and Lontzek (2019)
- Anticipation: Bilal and Rossi-Hansberg (2023), Bakkensen and Barrage (2022)

Contribution: Amplified consequences of uncertainty in decentralized framework

Beliefs and disagreement over aggregate (climate) process

- Hong et al. (2023), Bakkensen et al. (2023), Chen et al. (2012), Lontzek et al. (2024)

Contribution: Implications along the transition path

Contributions

Climate change impacts on the macroeconomy

- Stochastic damages: Golosov et al. (2014), Cai and Lontzek (2019)
- Anticipation: Bilal and Rossi-Hansberg (2023), Bakkensen and Barrage (2022)

Contribution: Amplified consequences of uncertainty in decentralized framework

Beliefs and disagreement over aggregate (climate) process

- Hong et al. (2023), Bakkensen et al. (2023), Chen et al. (2012), Lontzek et al. (2024)

Contribution: Implications along the transition path

Incomplete markets and aggregate risks: theory and computation

- Krusell and Smith (1998), Broer et al. (2022), Fernández-Villaverde et al. (2023), Bilal (2023), Auclert et al. (2021), Moll (2024)

Contribution: Non-stationarity in aggregate process, global solution method

Predictions in partial equilibrium

Consumption savings problem

An individual faces two types of uncertainty:

- Idiosyncratic $\phi \in \Phi$ (skills and demographics)
- Aggregate $\zeta \in Z = \{\zeta^L, \zeta^H\}$ (productivity)

Let $\theta_{it} = (\zeta_t, \phi_{it})$ denote overall state for agent i, and $\theta^{it} = (\theta_{i0}, \ldots, \theta_{it})$ history up to time t.

Consumption savings problem

An individual faces two types of uncertainty:

- Idiosyncratic $\phi \in \Phi$ (skills and demographics)
- Aggregate $\zeta \in Z = \{\zeta^L, \zeta^H\}$ (productivity)

Let $\theta_{it} = (\zeta_t, \phi_{it})$ denote overall state for agent i, and $\theta^{it} = (\theta_{i0}, \ldots, \theta_{it})$ history up to time t. Agent i chooses history-dependent consumption to maximize expected utility over life-time

$$\max_{c_{it}(\theta^{it})} \mathbb{E}\left[\sum_{t=0}^{\infty} \beta^t u(c_{it}(\theta^{it}))\right]$$

under individual subjective probability distribution, subject to budget constraint

$$c_{it}(\theta^{it}) + a_{it+1}(\theta^{it}) = y(\zeta_t, \phi_{it}) + R(\zeta_t) a_{it}(\theta^{it-1}), \;\; a_{it+1}(\theta^{it}) \geq 0.$$

Consumption savings problem

An individual faces two types of uncertainty:

- Idiosyncratic $\phi \in \Phi$ (skills and demographics): independent of climate change
- Aggregate $\zeta \in Z = \{\zeta^L, \zeta^H\}$ (productivity): possibly dependent on climate change

Let $\theta_{it} = (\zeta_t, \phi_{it})$ denote overall state for agent i, and $\theta^{it} = (\theta_{i0}, \dots, \theta_{it})$ history up to time t. Agent i chooses history-dependent consumption to maximize expected utility over life-time

$$\max_{c_{it}(\theta^{it})} \mathbb{E}\left[\sum_{t=0}^{\infty} \beta^t u(c_{it}(\theta^{it}))\right]$$

under individual subjective probability distribution, subject to budget constraint

$$c_{it}(\theta^{it}) + a_{it+1}(\theta^{it}) = y(\zeta_t, \phi_{it}) + R(\zeta_t) a_{it}(\theta^{it-1}), \;\; a_{it+1}(\theta^{it}) \geq 0.$$

How does consumption respond to a rise in the probability p_t of ζ^L?

First order consumption response

Implicit function theorem applied to Euler equation (Farhi et al., 2022)

$$\frac{dc_0}{c_0} = -\varepsilon(c_0)\sum_{t=0}^{\infty}\left(\sum_{\theta^t}\mathbb{P}^*(\theta^t)\left(\prod_{j=0}^{t} MPS(\theta^j)\right)\mathcal{D}_t(\theta^t)\right)dp_{t+1}. \tag{1}$$

Drivers of response:

- $\varepsilon(c) = -u'(c)/(cu''(c))$: elasticity of intertemporal substitution;
- $MPS = da/dy_0 = 1 - dc/dy_0$: marginal propensity to save;
- $\mathcal{D}_t(\theta^t)$: expected marginal value of holding an extra unit of assets in low versus high state
- $\mathbb{P}^*$: risk-adjusted probability measure over θ^t

First order consumption response

Implicit function theorem applied to Euler equation (Farhi et al., 2022)

$$\frac{dc_0}{c_0} = -\varepsilon(c_0) \sum_{t=0}^{\infty} \left(\sum_{\theta^t} \mathbb{P}^*(\theta^t) \left(\prod_{j=0}^{t} MPS(\theta^j) \right) \mathcal{D}_t(\theta^t) \right) dp_{t+1}. \tag{1}$$

Drivers of response:

- $\varepsilon(c) = -u'(c)/(cu''(c))$: elasticity of intertemporal substitution;
- $MPS = da/dy_0 = 1 - dc/dy_0$: marginal propensity to save;
- $\mathcal{D}_t(\theta^t)$: expected marginal value of holding an extra unit of assets in low versus high state
- $\mathbb{P}^*$: risk-adjusted probability measure over θ^t

Dependence on idiosyncratic state:

- ➤ MPS: small if borrowing constrained
- ➤ $\mathcal{D}_t(\theta^t)$: high for low asset holding and low expected income
- ➤ $\mathbb{P}^*$: larger weight on bad states

Empirical evidence

Empirical strategy

Does the increase in savings due to climate change concern hold in the data?

Goal: Estimate a relationship of the type

$$\mathfrak{s}_{it} = f(\iota_{it}, X_{it}; \varepsilon_{it}) \tag{2}$$

where $\mathfrak{s}_{it}$ is a savings indicator, ι_{it} is a measure of climate concern and X_{it} is a vector of controls.

Empirical strategy

Does the increase in savings due to climate change concern hold in the data?

Goal: Estimate a relationship of the type

$$\mathfrak{s}_{it} = f(\iota_{it}, X_{it}; \varepsilon_{it}) \tag{2}$$

where $\mathfrak{s}_{it}$ is a savings indicator, ι_{it} is a measure of climate concern and X_{it} is a vector of controls.

Two kinds of UK survey evidence:

1. Observational: large, representative UK panel survey (Understanding Society)
2. Causal: specific purpose online questionnaire

Observational data

UK Longitudinal Household Survey, waves 4 and 10 (2012-13, 2018-19)

- Construct index about climate change concern
- Savings variables (binary and amount)
- Demographic indicators
  - education, income, residence (LSOA), age, children

Exposure

- Flood data matched on residence

Observational data

UK Longitudinal Household Survey, waves 4 and 10 (2012-13, 2018-19)

- Construct index about climate change concern
- Savings variables (binary and amount)
- Demographic indicators
  - education, income, residence (LSOA), age, children

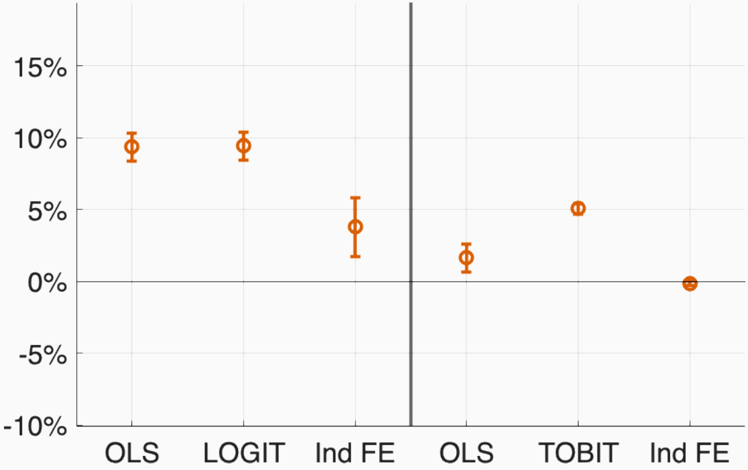
Exposure

- Flood data matched on residence

Addresses two main concerns:

1. Preferences over risk and time $\rightarrow$ Individual fixed effects
2. Idiosyncratic exposure $\rightarrow$ flood exposure, area fixed effects

Empirical results



Online Survey

Evidence from large scale survey has natural limitations:

- leaves questions open, e.g. what kind of climate impacts do respondents have in mind?
- crude measure of exposure, individual FE hinge on memory of previous response.

Online Survey

Evidence from large scale survey has natural limitations:

- leaves questions open, e.g. what kind of climate impacts do respondents have in mind?
- crude measure of exposure, individual FE hinge on memory of previous response.

Specific purpose online survey via Prolific/Qualtrics using within-subject design

Hypothetical savings choice under two scenarios presented in random order:
Frequency of climate-related events with significant negative consequences to the UK
(A) increases (B) stays constant (given baseline).
How much would you save out of a 5000 GBP transfer?

Questionnaire on overall concern, beliefs over specific mechanisms, personal savings behavior

Survey results

Marginal savings indicator: share of transfer saved

	Full sample
Δs	0.0763^{***}
	(0.0180)
Observations	543

➤ supports theory and observational evidence

Survey results

Marginal savings indicator: share of transfer saved

	Full sample
Δs	0.0763***
	(0.0180)
Observations	543

Income			
low	medium	high	NA
0.1002***	0.0715**	0.0534	0.0525
(0.0305)	(0.0311)	(0.0417)	(0.0362)
178	230	81	54

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

- supports theory and observational evidence
- highest effects for low income

Take-aways and open questions

Key take-aways:

- The passthrough of adverse macro risks to savings is non-negative and depends on current idiosyncratic state.
- Empirical evidence confirms relationship between climate concern and savings behavior, which cannot be fully attributed to preferences or exposure.

Open questions

- How does aggregate capital accumulation react to changes in disaster risk when allowing for indirect effects through savings adjustments?
- How does the observed disagreement over aggregate risks transmit to the macroeconomy?

$\rightarrow$ Dynamic general equilibrium model

General Equilibrium Model

Extension of Krusell-Smith

Households

- are subject to idiosyncratic shocks: income and life-cycle;
- consume and save to maximize EU, given budget constraint and borrowing limit.

Representative firm

- produces using capital and labor;
- is subject to productivity shocks ζ_t.

Extension of Krusell-Smith

Households

- are subject to idiosyncratic shocks: income and life-cycle;
- consume and save to maximize EU, given budget constraint and borrowing limit.

Representative firm

- produces using capital and labor;
- is subject to productivity shocks ζ_t.

Climate change

- causes non-stationary, exogenous shift in temperature:

$$T_{t+1} = \nu T_t + (1-\nu)\mu_T \quad \text{for} \quad t \geq 0;$$

- may increase frequency of low productivity states.

Climate change impacts

Probability of adverse aggregate shock is given by

$$\mathbb{P}(\zeta_t = \zeta^L) = p_t = p(T_t) = p^{1-\gamma T_t}.$$

Climate change impacts

Probability of adverse aggregate shock is given by

$$\mathbb{P}(\zeta_t = \zeta^L) = p_t = p(T_t) = p^{1-\gamma T_t}.$$

Parameter γ is unknown to agents.

- Two possible states of the world: $\gamma \in \{0, \ \overline{\gamma}\}$
- Each agent has a subjective belief $\mathbb{P}(\gamma = \overline{\gamma}) = \pi_{it}$.
- Bayesian updating

$$\pi_{it} = \pi_{it-1}\mathcal{P}_{it}, \text{ where } \mathcal{P}_{it}^{-1} = \begin{cases} \pi_{it-1} + (1-\pi_{it-1})p^{\overline{\gamma} T_t} & \text{if } \zeta_t = \zeta^L \\ \pi_{it-1} + (1-\pi_{it-1})\frac{1-p}{1-p^{1-\overline{\gamma} T_t}} & \text{if } \zeta_t = \zeta^H. \end{cases} \tag{3}$$

Climate change impacts

Probability of adverse aggregate shock is given by

$$\mathbb{P}(\zeta_t = \zeta^L) = p_t = p(T_t) = p^{1-\gamma T_t}.$$

Parameter γ is unknown to agents.

- Two possible states of the world: $\gamma \in \{0, \ \overline{\gamma}\}$
- Each agent has a subjective belief $\mathbb{P}(\gamma = \overline{\gamma}) = \pi_{it}$.
- Bayesian updating

$$\pi_{it} = \pi_{it-1}\mathcal{P}_{it}, \text{ where } \mathcal{P}_{it}^{-1} = \begin{cases} \pi_{it-1} + (1-\pi_{it-1})p^{\overline{\gamma}T_t} & \text{if } \zeta_t = \zeta^L \\ \pi_{it-1} + (1-\pi_{it-1})\frac{1-p}{1-p^{1-\overline{\gamma}T_t}} & \text{if } \zeta_t = \zeta^H. \end{cases} \tag{3}$$

Note:

- Differences in mean and variance, implicit level effect.
- Baseline assumption: $\gamma = \overline{\gamma}$ is the true model.

Consumer problem

Forward looking consumers base decisions on future income:

- Aggregate capital is endogenous outcome, but needed for individual choice.

Consumer problem

Forward looking consumers base decisions on future income:

- Aggregate capital is endogenous outcome, but needed for individual choice.

Assumption: bounded rationality
Decisions are based on Perceived Law of Motion (PLM)

$$K' = \mathcal{H}(K; \mathcal{X}) \quad \text{for some explanatory variables } \mathcal{X}.$$

Consumer problem

Forward looking consumers base decisions on future income:

- Aggregate capital is endogenous outcome, but needed for individual choice.

Assumption: bounded rationality
Decisions are based on Perceived Law of Motion (PLM)

$$K' = \mathcal{H}(K; \mathcal{X}) \quad \text{for some explanatory variables } \mathcal{X}.$$

How to choose PLM?
Find self-justified equilibrium to approximate rational expectations (Krusell and Smith, 1998)

- Estimate relationship on simulated data, controlling for shock, temperature, personal belief.
- Iterate on parameters until convergence; feasible due to novel stratified sampling procedure.

Alternatives, e.g. adaptive expectations, as robustness to address Moll (2024) critique.

Equilibrium and comparative statics

Dynamic equilibrium

For given processes $\{\zeta_t\}_{t\geq 0}, \{T_t\}_{t\geq 0}$, an initial distribution Ψ_0 and a PLM $\mathcal{H}$, the *dynamic equilibrium* of the economy is given by a sequence of distributions $\{\Psi_t\}_{t\geq 0}$ so that:

(a) Each period, the economy is in temporary equilibrium: households and firms optimize given their beliefs; markets clear.

(b) The distribution evolves consistently with the exogenous law of motion for demographics, Bayes' formula, and the endogenous choice function a'.

- No obvious point for comparisons
- Stochastic Steady State: fix ζ_t at mean $\rightarrow$ initial distribution
- Ensemble averages (stratified sample)

Calibration

Earnings and life-cycle:

- AR(1) process for skills estimated on UK panel data
- Expected work life/retirement duration: 40/20 years, replacement rate 60%.

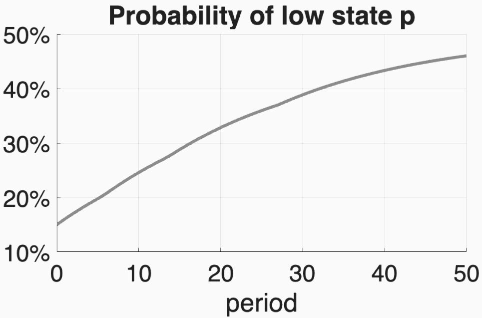
Aggregate shocks: Effect of climate change on UK productivity

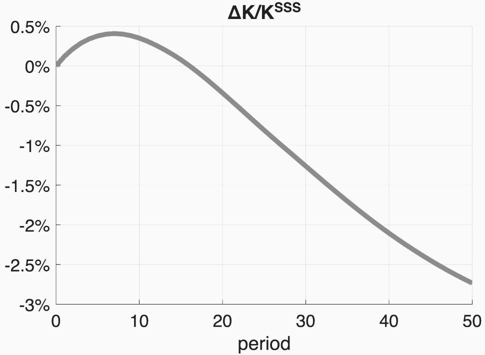
- AR(1) process for temperature, long-run increase of 0.9 deg within 75 years.
- Meta study Rising et al. (2022) estimates 1.1% in 2022, 3.3% by 2050, 7.4% by 2100.
- Bad states: $p = 0.15$, $\zeta^L = 0.93$. $\mathbb{E}_0(\zeta) = 0.9895$.

Model results

The climate transition under accurate beliefs

At time $t = 0$, everyone becomes aware of the shift in temperature and knows $\gamma = \overline{\gamma}$

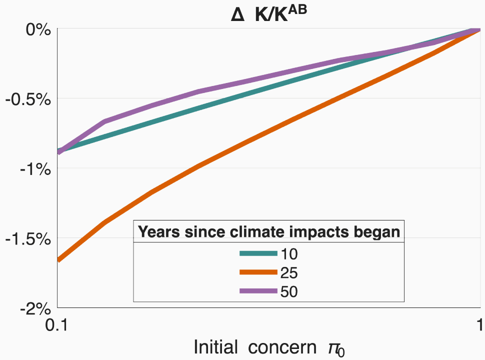


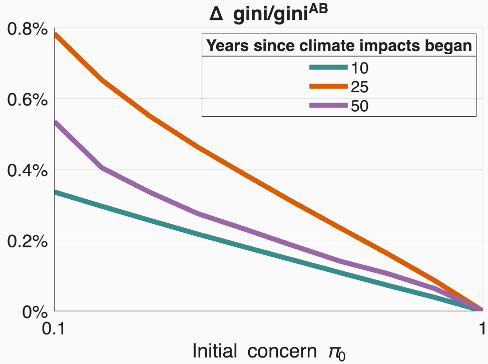


Increased savings in short run $\rightarrow$ smoothed transition

Capital accumulation under homogeneous beliefs

Inaccurate prior: capital ↓, inequality ↑



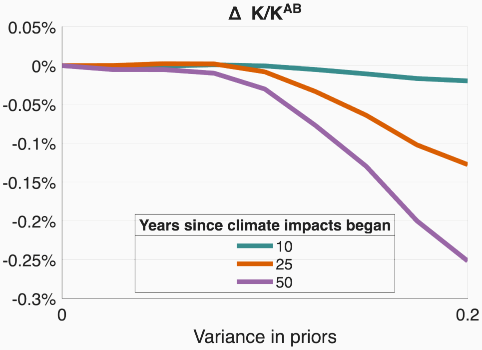


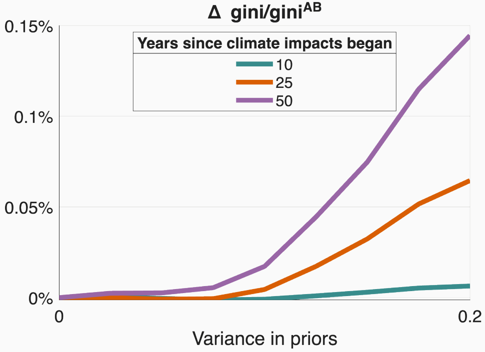
As long as prior $\pi > 0$: learning and long-run convergence.

For $\pi = 0$: long run divergence

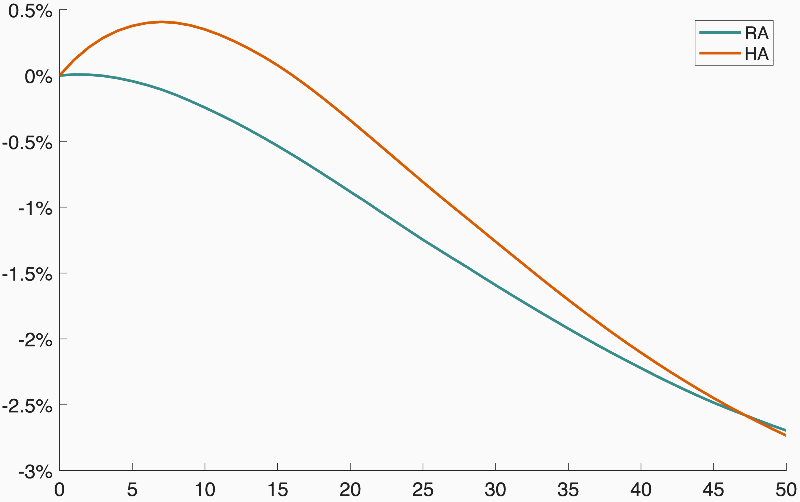
Capital accumulation under dispersed beliefs

Small effect of disagreement, but persistent.





Mechanisms: The role of incomplete markets



Conclusion

Micro behavior

- Climate concern affects individual savings decisions
- Consistent with a model of aggregate climate damages
- Cross-sectional heterogeneity rationalized by borrowing constraint

Macro effects

- Climate concern effect: capital increases in short-run
- Lack of capital accumulation exacerbates climate damages
- Heterogeneous impacts: low capital hurts poor more who rely on labor income
- Disagreement plays small but persistent role

References

Andre, P., Flynn, J. P., Nikolakoudis, G. and Sastry, K. (2025), 'Quick-fixing: Near-rationality in consumption and savings behavior', *NBER Working Paper Series* .

Auclert, A., Bardóczy, B., Rognlie, M. and Straub, L. (2021), 'Using the sequence-space jacobian to solve and estimate heterogeneous-agent models', *Econometrica* **89**, 2375–2408.

Bakkensen, L. A. and Barrage, L. (2022), 'Going underwater? flood risk belief heterogeneity and coastal home price dynamics', *The Review of Financial Studies* **35**, 3666–3709.
URL: *https://doi.org/10.1093/rfs/hhab122*

Bakkensen, L., Phan, T. and Wong, T.-N. (2023), 'Leveraging the disagreement on climate change: Theory and evidence', *Federal Reserve Bank of Richmond Working Papers* **23**, 1–75.

Bilal, A. (2023), 'Solving heterogeneous agent models with the master equation', *NBER Working Paper Series* .

Bilal, A. and Rossi-Hansberg, E. (2023), Anticipating climate change across the united states, Technical report, National Bureau of Economic Research.
URL: *http://www.nber.org/papers/w31323*

Broer, T., Kohlhas, A., Mitman, K. and Schlafmann, K. (2022), 'Expectation and wealth heterogeneity in the macroeconomy', *CEPR Discussion Paper* .

Cai, Y. and Lontzek, T. S. (2019), 'The social cost of carbon with economic and climate risks', *Journal of Political Economy* **127**, 2684–2734.

Chen, H., Joslin, S. and Tran, N.-K. (2012), 'Rare disasters and risk sharing with heterogeneous beliefs', *The Review of Financial Studies* **25**, 2189–2224.
URL: *https://doi.org/10.1093/rfs/hhs064*

Farhi, E., Olivi, H. A. and Werning, I. (2022), Price theory for incomplete markets *, Technical report.

Fernández-Villaverde, J., Hurtado, S. and Nuño, G. (2023), 'Financial frictions and the wealth distribution', *Econometrica* **91**, 869–901.

Golosov, M., Hassler, J., Krusell, P. and Tsyvinski, A. (2014), 'Optimal taxes on fossil fuel in general equilibrium', *Econometrica* **82**, 41–88.
URL: *https://onlinelibrary.wiley.com/doi/abs/10.3982/ECTA10217*

Hong, H., Wang, N. and Yang, J. (2023), 'Mitigating disaster risks in the age of climate change', *Econometrica* **91**, 1763–1802.

Krusell, P. and Smith, A. A. J. (1998), 'Income and wealth heterogeneity in the macroeconomy', *Journal of Political Economy* **106**, 867–896.
URL: *http://www.jstor.org/stable/10.1086/250034*

Lontzek, T., Pohl, W., Schmedders, K., Thalhammer, M., Wilms, O., Allard, A.-F., Bansal, R., Branger, N., Fama, E., Fabisik, K., Gao, C., Hansen, L. P., Judd, K. L., Koijen, R., Nagel, S., Pflueger, C., Pouget, S., Rossi-Hansberg, E., Schneider, C. and Whelan, P. (2024), Asset pricing with disagreement about climate risks *, Technical report.

Moll, B. (2024), The trouble with rational expectations in heterogeneous agent models: A challenge for macroeconomics.

Rising, J., Dietz, S., Dumas, M., Khurana, R., Kikstra, J., Lenton, T., Linsenmeier, M., Smith, C., Taylor, C. and Ward, B. (2022), What will climate change cost the uk? risks, impacts and mitigation for the net-zero transition, Technical report, Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science.

Descriptive Statistics: Index